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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

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| Applicant's or agent's file reference FP2130/TLW | FOR FURTHER ACTION | See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416). |
| International Application No. PCT/SG2003/000294 | International Filing Date (day/month/year) 30 December 2003 | Priority Date (day/month/year) 30 December 2003 |
| International Patent Classification (IPC) or national classification and IPC Int. Cl. 7 G01N 21/88, 21/958 | | |
| Applicant AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH et al | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheet(s).

3. This report contains indications relating to the following items:

- I Basis of the report
- II Priority
- III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV Lack of unity of invention
- V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI Certain documents cited
- VII Certain defects in the international application
- VIII Certain observations on the international application

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|---|--|
| Date of submission of the demand 9 June 2004 | Date of completion of the report 10 January 2005 |
| Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929 | Authorized Officer JULIA HU Telephone No. (02) 6283 2754 |

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I. Basis of the report**1. With regard to the elements of the international application:***

- the international application as originally filed.
- the description, pages 1-4, 7-17, as originally filed,
pages , filed with the demand,
pages 5, 6, 6a, received on 24 November 2004 with the letter of 24 November 2004
- the claims, pages 19-20, 22-24, as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages 18, 21, received on 24 November 2004 with the letter of 24 November 2004
- the drawings, pages 1/7-7/7, as originally filed,
pages , filed with the demand,
pages , received on with the letter of
- the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

- the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- the language of publication of the international application (under Rule 48.3(b)).
- the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- contained in the international application in written form.
- filed together with the international application in computer readable form.
- furnished subsequently to this Authority in written form.
- furnished subsequently to this Authority in computer readable form.
- The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. The amendments have resulted in the cancellation of:

- the description, pages
- the claims, Nos.
- the drawings, sheets/fig.

5. This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

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V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | |
|-------------------------------|-------------|-----|
| Novelty (N) | Claims 1-43 | YES |
| | Claims | NO |
| Inventive step (IS) | Claims 1-43 | YES |
| | Claims | NO |
| Industrial applicability (IA) | Claims 1-43 | YES |
| | Claims | NO |

2. Citations and explanations (Rule 70.7)

NOVELTY (N) AND INVENTIVE STEP (IS) claims 1-43

The invention of the claims is a method/apparatus for detecting faults within a transparent panel, comprising placing a light-transmissive interface in contact with the panel and transmitting a beam of light through the interface into the panel, and propagating within the panel along a path where total internal reflection is realized at surfaces of the panel; and observing the light scattered by the faults and exiting the panel.

All of the documents cited in the International Search Report were category "A" only. No individual citation or obvious combination of citations disclose or fairly suggest such a method/apparatus.

The closest art of JP 2001-305072 and JP 2000-074848 each discloses a method/apparatus where scattered light from a default is detected while light propagates through a transparent panel/substrate by total internal reflection. However, there is no light transmissive interface in contact with the transparent panel.

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advantageous for the two reasons. Firstly, most of the transparent panels, such as the toughed glass panels have a high absorption coefficient. Without the efficient use of the light energy, even with a high power light source, the field of view will still be very small, which results in a very slow inspection speed. Secondly, without the light leakage, the contrast of the images is high; all the defects are bright points like stars against the dark background of the other area of the panel.

As noted above, many transparent panels include a printed pattern, such as 10 black dots on one side of the panel, that results in great difficulty for known inspection methods. However, a method according to the present invention may still work very well under these circumstances.

Most preferably, the panel is a glass panel, but the invention can also usefully 15 be used for panels of other transparent material, such as a transparent polymer, which is capable to providing total internal reflection to a beam of light propagating within it.

Also, although as noted above, the invention is particularly useful for detecting 20 inclusions or other internal faults in the panel (e.g. cracks, air bubbles and other foreign substance), it may also be used for detecting surface faults such as scratches or dents.

Specifically, one expression of the invention is a method for detecting faults, 25 such as inclusions, within a transparent panel which is located in an ambient atmosphere, the method comprising:

directing light from a light source into an interface in contact with the transparent panel, the interface including one or more interface elements having a refractive index higher than the ambient atmosphere, at least some 30 of the light passing through the interface into the transparent panel and

propagating within the transparent panel along a path where total internal reflection (TIR) is realized at the surface of the transparent panel; and
observing at least some of any of light scattered by the faults and exiting the panel.

5

An alternative expression of the invention is an apparatus for detecting faults, such as inclusions, within a transparent panel which is located in an ambient atmosphere, the apparatus comprising:

a light source;

10 an interface including one or more interface elements having a refractive index higher than the ambient atmosphere and transparent to light generated by the light source;

light source support means for locating the light source in a positional relationship to the interface such that when the interface is contacting the 15 panel, light generated by the light source is transmitted through the interface into the panel and propagates within the panel along a path where total internal reflection is realized at the surface of the panel; and

20 a detector for detecting light scattered by the faults and exiting the panel.

20

Brief Description of The Figures

Preferred features of the invention will now be described, for the sake of illustration only, with reference to the following figures in which:

Fig. 1 shows the principle underlying an embodiment of the invention;

25 Fig. 2 shows schematically a second view of the embodiment of Fig. 1 in which the light source is a fibre bundle;

Fig. 3 shows a second embodiment of the invention;

6a

Fig. 4, which is composed of Figs. 4(a) to 4(c), shows schematically the interaction of an NiS inclusion or other fault with light in the embodiment of Fig. 2, and experimental results obtained by such a technique;

Claims

1. A method for detecting faults, such as inclusions, within a transparent panel which is located in an ambient atmosphere, the method comprising:
 - 5 directing light from a light source into an interface in contact with the transparent panel, the interface including one or more interface elements having a refractive index higher than the ambient atmosphere, at least some of the light passing through the interface into the transparent panel and propagating within the transparent panel along a path where total internal reflection is realized at surfaces of the transparent panel; and
 - 10 observing the light scattered by the faults and exiting the panel.
2. A method according to claim 1 in which the one or more interface elements include a body of flexible material which is pressed against the panel, whereby the body is deformed to increase the area of the panel with 15 which it is in contact.
3. A method according to claim 2 in which the body is composed of silicone rubber.
- 20 4. A method according to claim 1, claim 2 or claim 3 in which the interface includes a plurality of the interface elements, each having a refractive index greater than the ambient medium.
- 25 5. A method according to any preceding claim in which the interface further includes a liquid coupling layer interposed between the panel and the one or more interface elements.
6. A method according to claim 5 in which the liquid coupling layer is substantially composed of water.

cameras being arranged to observe the illuminated region of the panel from different directions.

- 5 22. A method according to claim 21 when dependent on any of claims 18 to 20, in which the automated image analysis system determines the position of a detected inclusion in the thickness direction of the panel.
- 10 23. A method according to any preceding claim in which the transparent panel is glass.
24. A method according to any of claims 1 to 22 in which the transparent panel is a transparent polymer.
- 15 25. An apparatus for detecting faults, such as inclusions, within a transparent panel which is located in an ambient atmosphere, the apparatus comprising:
 - a light source;
 - an interface including one or more interface elements having a refractive index higher than the ambient atmosphere and transparent to light generated by the light source;
 - 20 light source support means for locating the light source in a positional relationship to the interface such that when the interface is contacting the panel, light generated by the light source is transmitted through the interface into the panel and propagates within the panel along a path where total internal reflection is realized at surfaces of the panel; and
 - 25 a detector for detecting light scattered by the faults and exiting the panel.
- 30 26. An apparatus according to claim 25 in which the one or more interface elements include a body of flexible material, whereby upon pressing the body against the panel the body is deformed to conform to the surface of the panel.